The Effect of Default Mode Network Transcranial Direct Current Stimulation on Open-Minded Cognition

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Introduction

- Open-Minded Cognition (OMC) refers to the extent to which an individual is willing to consider others' ideas and perspectives that may differ from their own. OMC has been shown to be highly correlated with Openness to Experience (Price et al., 2015), which Beaty et al. (2016) have found to be correlated with Default Mode Network (DMN) global efficiency.
- Previous research has also suggested that the right Dorsolateral Prefrontal Cortex (rDLPFC) is associated with partisan differences and biases, suggesting a theoretical association with OMC.
- The Earned Dogmatism Effect asserts that individuals are more likely to be closed-minded to others' ideas and information when they perceive themselves to have greater expertise on a topic relative to others (Ottati et al., 2018).
- In this study we investigate if 1) the DMN is important for OMC, 2) the rDLPFC is important for OMC, and 3) whether enhancing the probability of firing in the DMN or rDLFPC via High Density anodal transcranial Direct Current Stimulation (tDCS) could enhance OMC and thereby decrease the Earned Dogmatism Effect.

Methods

- 148 Loyola students participated in study approved by the Loyola University Chicago IRB. The received either course credit of a gift card in exchange for their participation.
- Participants were 18 – 35 years old, right-handed fluent English speaker. Excluded from the study if they answer yes to any of the following questions: 1) Are you less than 18 or older than 35 years of age? 2) Are you left-handed? 3) Do you have any metal in your head or neck that is NOT dental work? 4) Do you have an implanted pacemaker or deep brain stimulator? 5) Are you currently pregnant? 6) Have you ever been diagnosed with a significant neurological disorder (including seizure, multiple sclerosis, epilepsy, cerebral palsy, encephalitis, stroke, dementia, Traumatic Brain Injury, etc.) or a previous head injury causing a loss of consciousness? or 7) Are you suffering from any psychiatric disorders that even with treatment severely interfere with your ability to function in either social or occupational (including school) settings
- Participants were randomly assigned to one of three tDCS conditions. These included a 1) sham 30-min stimulation condition (20s at beginning and end) or 2mA High Definition anodal tDCS using a 5-electrode montage on a Soterix Transcranial Electric Stimulation device targeting either 2) Posterior Cingulate Cortex (Default Mode Network), or 3) rDLPFC (See Figure 1).
- During stimulation participants were asked to recall two real situations where they knew more than (expert condition) and about the same as (novice condition) someone else about a topic.
- Participants then completed a measure of situation-specific OMC (SOMC) following each recalled situation. This included items such as, "In this situation, I am open to considering other viewpoints".
- We predicted a replication of the Earned Dogmatism effect such that individuals in the expert condition would greater SOMC compared to those in the novice condition. Furthermore, participant's in both the DMN and rDLPFC stim conditions ought to report higher SOMC in the expert condition relative to sham such that there would be no difference between the expert and novice conditions for the stim conditions, thus eliminating the Earned Dogmatism effect.

Results

Figure 1. Stimulation sites for High Definition anodal tDCS

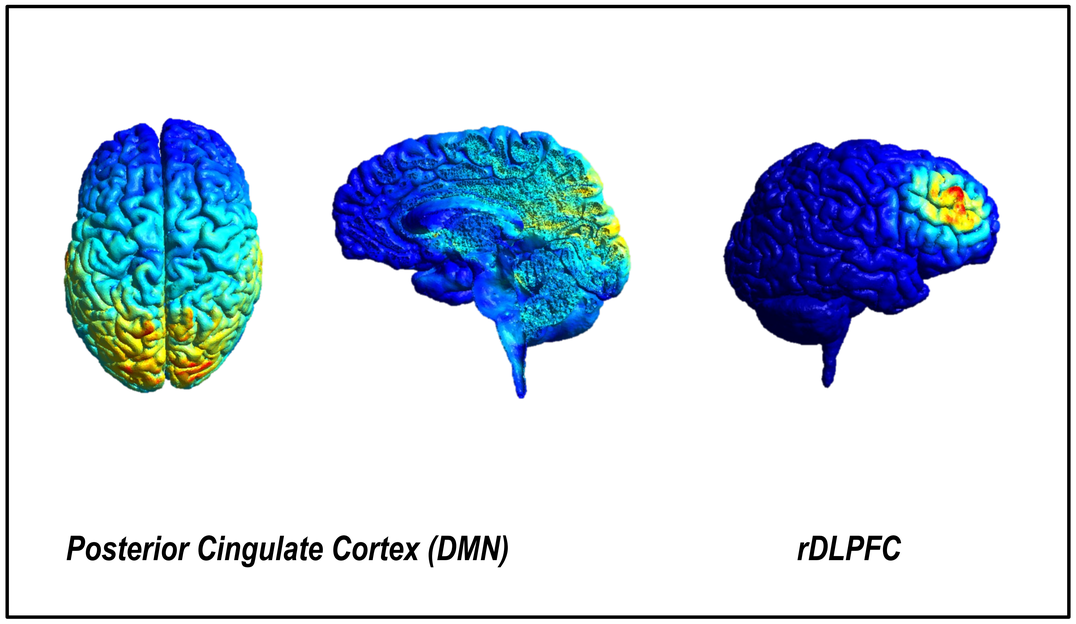
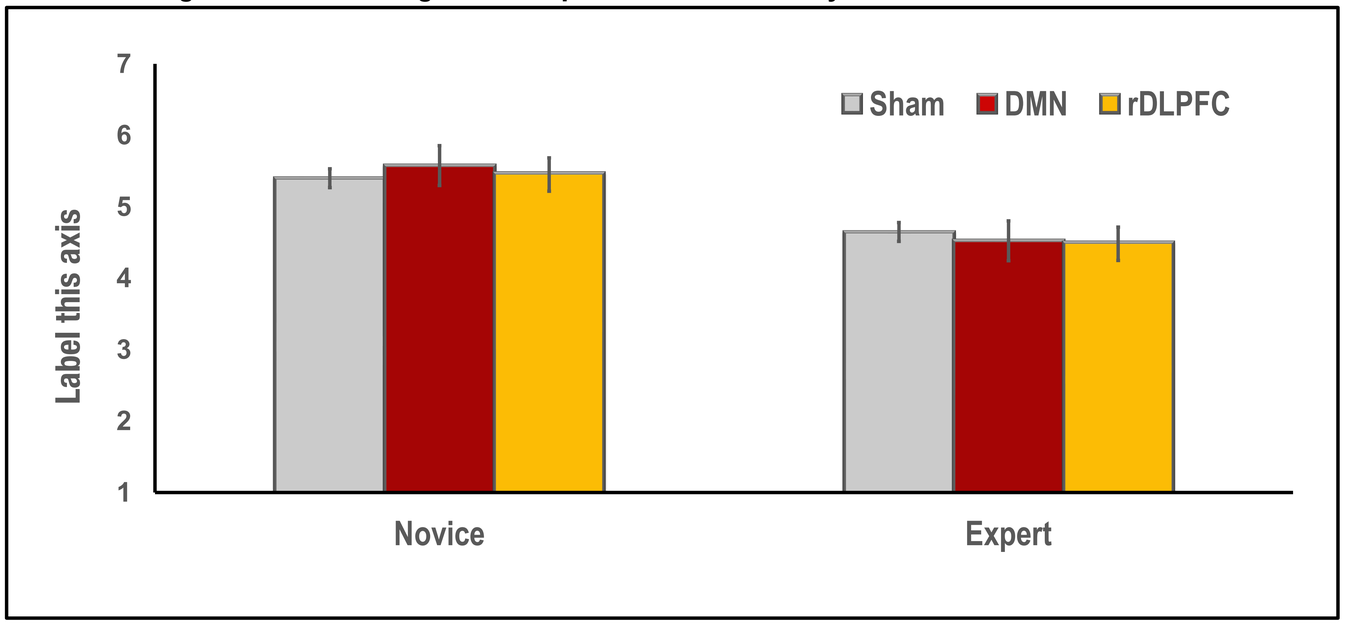


Figure 2. Earned Dogmatism Optimal Recall Task by Stimulation Condition



- A main effect of recall condition was found such that the expert recall condition (M = 4.6) elicited less open-mindedness than the novice recall condition (M = 5.42; $t(147)$ = 8.21, p < .0001). That is, participants were more dogmatic when in the expert condition than in the novice recall condition.
- No main effect of stimulation condition was found on SOMC, $F(2,145)$ = .025, p = .976. That is, no significant differences were found across the sham (M = 5.40), DMN (M = 5.78), or rDLPFC (M = 5.47) in the novice condition. Similarly, no significant differences were found across the sham (M = 4.65), DMN (M = 4.52), or rDLPFC (M = 4.50).
- No interaction effect was found between recall condition and stimulation condition on SOMC, $F(2,145)$ = .726, p = .486.

Conclusion

- The significant main effect of optimal recall condition on SOMC replicates past work from Ottati et al. (2018) regarding the Earned Dogmatism effect.
- No main effect of stimulation was found on SOMC, nor was the interaction significant. This may suggest that, while OMC and openness to experience are related constructs (e.g., Beaty et al., 2016), OMC's relationship to both the DMN and rDLPFC may differ.
- OMC is theoretically understood to capture the width of processing rather than the depth of processing. That is people with greater OMC may be willing to consider a broader range of political ideas. It does not capture the depth to which an individual may be willing to consider a topic, such as need for cognition (Cacioppo & Petty, 1982). Thus, while it appears that neither DMN or rDLPFC stimulation affected scores on OMC, future studies should explore how it may affect depth of processing.

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